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ORIGINAL PAPER

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THE DETERMINATION OF ANTIOXIDANT CAPACITIES AND CHEMICAL PROPERTIES OF ROSA (*Rosa damascena* Mill.) PRODUCTS

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ABSTRACT

Some chemical properties, anthocyanin and total phenolic content and antioxidant capacity of some rosa products namely petals, syrups, jams and leavens were determined. Antimicrobial activities of rose petals and rosa leavens were also investigated. Total dry matter, total soluble solids, ash, pH, titratable acidity, reducing sugar, sucrose, total sugar, color (*L*, *a*, *b*), total phenolic content, antioxidant capacity (β-caroten bleaching method, DPPH free radical-scavenging activity (IC_{50}), TEAC, (IC_{50})) of rosa petals were determined as 18.43%; 10.35%; 0.90%; 5.30; 0.99%; 4.66 g·100 g^{-1}; 1.72 g·100 g^{-1}; 6.38 g·100 g^{-1}; 38.98; +17.3; –3.44; 481.54 µg GAE·mg^{-1} sample; 88.6%; 0.97 µg·ml^{-1}; 9.36 µg·ml^{-1}, respectively. Rosa petals and leavens extracts showed significant antimicrobial activity against *Acinetobacter lwoffii*, *Bacillus cereus*, *Proteus mirabilis* GM 2644, *Staphylococcus aureus* ATCC 29213, *Streptococcus mutans* ATCC 35668 and *Yersinia enterocolitica*. In rosa leaven, the sample types were found effective significantly ($p < 0.01$) on total dry matter, total soluble solids, ash, titratable acidity, pH; *L* and *b* values; total anthocyanin content, total phenolic content and antioxidant capacity. In rosa syrup, the sample types were found effective significantly ($p < 0.01$) on total dry matter, total soluble solids, pH, titratable acidity, *L*, *a*, *b*, total phenolic content and antioxidant capacity. In rosa jam, the sample types were found effective significantly ($p < 0.01$) on total dry matter, total soluble solids, ash, titratable acidity, pH, total sugar, sucrose, reducing sugar, HMF, *a* value, total phenolic content and antioxidant capacity.

Key words: *Rosa damascena*, anthocyanin, HPLC, antioxidant activity, antimicrobial activity

INTRODUCTION

Plants particularly horticulture section are raw material and used by people for food, either as edible products, or for culinary ingredients, for medicinal use or ornamental and aesthetic purposes. They are genetically very diverse group and play a major role in modern society end economy [Hricova et al. 2016, Sakar et al. 2016, Saridas et al. 2016, Solmaz et al. 2016].

Rose, of the family Rosaceae, has brilliant colors, rich aroma and high trophic value. It is an important raw material for the production of spices and functional food [Ge and Ma 2013]. Roses are the im-

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portant ornamental plants and have been named as the queen of flowers. Over 150 rose species and more than 2000 cultivars have been registered [Kumar et al. 2009].

Rosa damascena Mill. (Damask rose, oil-bearing rose, pink rose) is the most important rose species producing high-value essential oil. Bearing in mind that Turkey is one of the most important country growing industrial *R. damascena* in the world together with Bulgaria. From 6000 to 8000 t of rose flowers are produced annually for essential oil, rose water, concrete and absolute production in Isparta province at the Southwest region of Turkey [Ercisli 2005]. The main flowering season in the region is a period with 40 days of May and June months. The flowers collected freshly in the early hours of the days in this period are hydro-distilled for rose oil and rose water production, and also extracted with organic solvents for concrete and absolute production [Ercisli 2005]. Annual rose oil, concrete and absolute production of Turkey are 1.2–1.8, 6–9, and 2–2.5 t, respectively with high exporting qualities. These high-price products for flavorings, fragrance and pharmaceutical industries are mainly imported by the USA and EU countries [Baydar and Baydar 2013].

Rose petals have been consumed in many cultures for many years especially as jams, teas, cakes, and flavor extracts. They were also used in medicinal practices for remedy of various illnesses [Friedman et al. 2010]. Essential oil from rose petals is a highly prized product used in perfumery, cosmetics, pharmacy and food industry [Shikov et al. 2012]. Members of the Rosaceae family have long been used for food and medicinal purposes [Kumar et al. 2009].

To best of our knowledge, there is no previous report in the literature on chemical composition, anthocyanin profile, antioxidant and antimicrobial activities of rose petals and their products. So, the present investigation was focused on: (i) to identify some physical and chemical composition, (ii) to establish anthocyanin profile (iii) to study the *in vitro* antioxidant potential and (iv) to investigate the antimicrobial activity of rose petals and their some products.

MATERIAL AND METHODS

Plant material

In this study, fresh petals of *R. damascena* Mill. were used as plant materials. The petals with pink color were collected freshly in the early hours of the days from the rose garden of Gülbirlik (Rose farmer association) at Isparta, Turkey. Fresh petals kept in a refrigerator at 4°C until analyses. The leaven, syrup and jam samples purchased various producer firms in Isparta city of Turkey.

Methods

Total dry matter, total soluble solid (TSS), ash, pH and titratable acidity were determined according to standard AOAC [1984] method, pH was determined with a ATI ORION 420A model pH meter; titratable acidity, expressed as percentage of citric acid, was determined with 0.1 N NaOH up to pH 8.1; solubles dry matter was determined with an Abbe-Zeis refractometer; total sugar, reducing sugar and sucrose contents were analysed by the Lane-Eynon method [Cemeroğlu 2010]. Reducing sugar concentration was measured before inversion whereas total sugar was determined after inversion. Sucrose was calculated by subtracting the reducing sugar concentration from the total invert sugar and multiplying the result by 0.95. Color of mulberry fruit was analysed by measuring Hunter L (brightness; 100 white, 0 black), a (+ red; − green) and b (+ yellow; − blue) parameters with a colorimeter (Model CR 200, Chromometer, Minolta, Japan).

Total phenolic contents of extracts were determined using Folin–Ciocalteu method [Gulcin et al. 2002]. Antioxidant activity of extracts determined by three different assays β-carotene bleaching assay [Kaur and Kapoor 2002], DPPH [Gulcin 2005] and TEAC [Gulcin et al. 2012]. Total monomeric anthocyanin content was determined according to the pH differential method, as described by Sun et al. [2009]. The anthocyanin profiles of extracts were analyzed by HPLC method [Zhang et al. 2004, Tural and Koca 2008]. The antibacterial effect was tested by the disc-diffusion method [Sengul et al. 2009].

RESULT AND DISCUSSION

Rose petals

The physical and chemical properties of rose petals are given in table 1. The total dry matter, total soluble solids, total sugar, sucrose, reducing sugar, ash, pH, titratable acidity (citric acid), vitamin C contents and color (*L, a, b*) values were established as 18.43%, 10.35%, 6.38%, 1.72%, 4.66%, 0.90%, 5.30, 0.99%, 45.0 mg·100 g^{-1}, 38.98, 17.30, –3.44 respectively. Vitamin C content of rose petals is reported as 91.52 mg·100 g^{-1} [Velioğlu 1990]. The content of vitamin C in fruits and vegetables can be influenced by various factors such as genotypic differences, preharvest climatic conditions and cultural practices, maturity and harvesting methods, and postharvest handling procedures. Many pre- and postharvest factors influence the vitamin C content of horticultural crops. Climatic conditions and cultural practices, maturity at harvest, harvesting method, and postharvest handling conditions affect the vitamin C content of fruits and vegetable. Processing methods and cooking procedures can result in significant losses of vitamin C [Lee and Kader 2000].

Table 1. Chemical properties of rose petals

Property	Values
Total dry matter (%)	18.43 ±1.24
Total soluble solids (%)	10.35 ±0.87
Ash (%)	0.90 ±0.07
pH	5.30 ±0.42
Titratable acidity (citric acid, %)	0.99 ±0.06
Vitamin C (mg·100 g^{-1})	45.00 ±3.41
Reducing sugar (g·100 g^{-1})	4.66 ±0.33
Sucrose (g·100 g^{-1})	1.72 ±0.12
Total sugar (g·100 g^{-1})	6.38 ±0.76
L	38.98 ±3.11
a	17.30 ±1.21
b	–3.44 ±0.26

Explanations: *L* – lightness, *a* – green-red, *b* – blue-yellow

Table 2 presents total phenolic content and antioxidant activities of rose petals ethanolic extracts. The total phenolic content of rose petals was 481.54 µg GAE·mg $sample^{-1}$. Ge and Ma [2013] established that total phenolic content in petals of Yunnan edible roses was (2087.43 ±17.37) mg GAE·100 g fresh $weight^{-1}$. Phenolics possess antioxidant activity and they have been characterized as phenolic acids and flavonoids. Phenolic acids (e.g. caffeic acid, ferulic acid, and vanillic acid) have been implicated as natural antioxidants in fruits, vegetables, and other plants [Javanmardi et al. 2003].

Table 2. Total phenolic contents and antioxidant capacities of rose petals

Parameters	Rose petals	BHA	Trolox
Total phenolic content (µg GAE·mg $sample^{-1}$)	481.54	–	–
β-carotene bleaching assay (%)	88.60	98.76	–
TEAC (IC_{50}, µg·ml^{-1})	9.36	98.76	–
DPPH (IC_{50}, µg·ml^{-1})	0.97	–	11.10

Antioxidant activity of rose petals determined by three different assays β-carotene bleaching assay (BCB), TEAC and DPPH (tab. 2). In the BCB assay, linoleic acid produces hydroperoxides during incubation at 50°C. The presence of hydroperoxides cause rapid discoloration of β-carotene. However, hydroperoxides formed in this system can be neutralised by the antioxidants from the extracts [Ismail et al. 2010]. Table 2 shows the mean total antioxidant activity of rose petals. The means of total antioxidant activity for rose petals was 88.60%. BHA, used as the standard, had a higher antioxidant activity than rose petals extracts.

DPPH radical-scavenging activity has been extensively used for screening antioxidants, such as polyphenols and anthocyanins, from fruits. DPPH· is scavenged by polyphenols and anthocyanins through the donation of hydrogen, forming the reduced DPPH-H^{*}. The colour changes from purple to yellow after reduction can be quantified by its decrease of

Table 3. Total monomeric anthocyanin and individual anthocyanin content of rose petals

Compound	Content
Total anthocyanin (mg·100 ml^{-1})	155.31 ±7.24
Malvidin-3,5-diglucoside (μg·l^{-1})	19.25 ±1.11
Cyanidin-3-O-glucoside chloride (μg·l^{-1})	4.59 ±0.13
Apigenin-7-glucoside (μg·l^{-1})	4.59 ±1.12
Cyanidin-3,5-di-O-glucoside (μg·l^{-1})	8.79 ±1.64
Pelargonidin-3,5-di-O-glucoside chloride (μg·l^{-1})	15.14 ±2.11
Delphinidin chloride (μg·l^{-1})	4.89 ±1.04
Pelargonidin-3-O-glucoside chloride (μg·l^{-1})	9.50 ±1.54

absorbance at wavelength 517 nm [Yang and Zhai 2010]. DPPH free radical-scavenging activities of rose petals extract and Trolox are shown in table 2. The lower the IC_{50} value is, the greater the free radical-scavenging activity is [Yang and Zhai 2010]. The IC_{50} values of the DPPH radical-scavenging activities were 0.97 and 28.20 for rose petals and trolox, respectively. These results revealed that rose petals had significantly ($p < 0.05$) higher scavenge power than trolox. Rose-petal tea may serve as caffeine-free beverage with high antioxidant capacity, and may be consumed either separately or in combination with other herbal materials. The radical scavenging activity in rose petal is mostly due to the high content of phenolic compounds, in particular free gallic acid [Vinokur et al. 2006].

TEAC (trolox equivalent antioxidant capacity) assay, which has attracted much interest because it enables high-throughput screening of potential antioxidant activity of single compounds and biological matrices, such as plasma, as well as food components, food extracts or beverages. This assay is based on the antioxidant's ability to react with $ABTS_{\bullet}$ radical cation generated in the assay system [Gliszczyńska-Świgło 2006]. The IC_{50} values of the rose petals extracts is presented in Table 2. The IC_{50} values were 9.36 and 11.20 for rose petals and trolox, respectively.

The pH differential method and HPLC method are the commonly applied methods by the researchers and food industry for quantifying anthocyanin contents of foods. The pH differential method is a simple, rapid and an economical means for determining the amount of anthocyanin contents in a sample. On the other hand, HPLC is an invaluable tool for identifying as well as quantifying individual anthocyanin in foods [Giusti et al. 1999]. Total anthocyanin content of rose petals samples were determined by spectrophotometric pH differential and HPLC methods (tab. 3). Monomeric anthocyanin content determined by the pH differential technique is also known as the total anthocyanin content. The monomeric anthocyanin content of the samples was found 155.31 mg·100 g^{-1}.

All the trials were performed in triplicate ($n = 3$) and all the data were reported as means ± SD; TAC expressed as mg of cyanidin-3-glucoside per 100 ml. Data in the same column with different letters are significantly different ($p < 0.05$).

Analysis of anthocyanins in rose petals by means of HPLC method was performed. The contents of malvidin-3,5-diglucoside, cyanidin-3-O-glucoside chloride, apigenin-7-glucoside, cyanidin-3,5-di-O-glucoside, pelargonidin-3,5-di-O-glucoside chloride, delphinidin chloride and pelargonidin-3-O-glucoside chloride were 19.25, 4.59, 4.59, 8.79, 15.14, 4.89, and 9.50 μg·l^{-1}, respectively (tab. 3).

The results of antimicrobial activity of ethanol extracts are shown in Table 4. The ethanol extract of rose petals were proved to possess considerable antimicrobial potentiality against a number of microorganisms (tab. 4). The ethanol extracts from rose petals

showed antimicrobial activity against 6 out of 14 microorganisms. The inhibition zones of the microorganisms sensitive to the ethanol extract were 6.70–11.60 mm, respectively (tab. 4). The highest inhibition zone (11.60 mm) was observed in rose petals against *Proteus mirabilis* GM 2644 while the lowest inhibition zone (6.70 mm) was observed against *Yersinia enterocolitica* (tab. 4).

Table 4. Antimicrobial properties of rose petals extracts

Foodborne-microorganisms	Diameter of inhibition (mm)	Positive control*
Acinetobacter lwoffii 2819	10.70	17 (AMC30)
Bacillus cereus	8.30	12 (CC2)
Candida albicans ATCC1223	–	15 (AMP20)
Candida albicans ATCC90059	–	15 (AMP20)
Candida krusei ATCC14243	–	15 (AMP20)
Escherichia coli GM1402	–	18 (CC2)
Listeria ivanovii GM8353	–	19 (CC2)
Proteus mirabilis GM 2644	11.60	12 (OFX10)
Saccharomyces boulardii GM6128	–	9 (AMP20)
Saccharomyces cerevisiae GM6541	–	8 (AMP20)
Salmonella typmiruim RSSK95091	–	9 (OFX10)
Staphylococcus aureus ATCC 29213	10.30	20 (SCF105)
Streptococcus mutans ATCC 35668	9.70	18 (AMP10)
Yersinia enterocolitica	6.70	26 (AZM15)

– no inhibition zone

* SCF105 (30 µg sulbactam + 75 µg cefoperazona/disc), CC2 (2 µg clindamycin/disc), OFX10 (10 µg ofloxacin/disc), AMC30 (20 µg amoxicillin + 10 µg clavulanic acid/disc), AZM15 (15 µg azithromycin/disc), AMP20 (20 µg Amphotericin B/disc), AMP10 (10 µg Amphotericin B/disc) used as positive standards antibiotic discs (oxoid)

Table 5. Total phenolic contents and antioxidant capacities of rose leavens

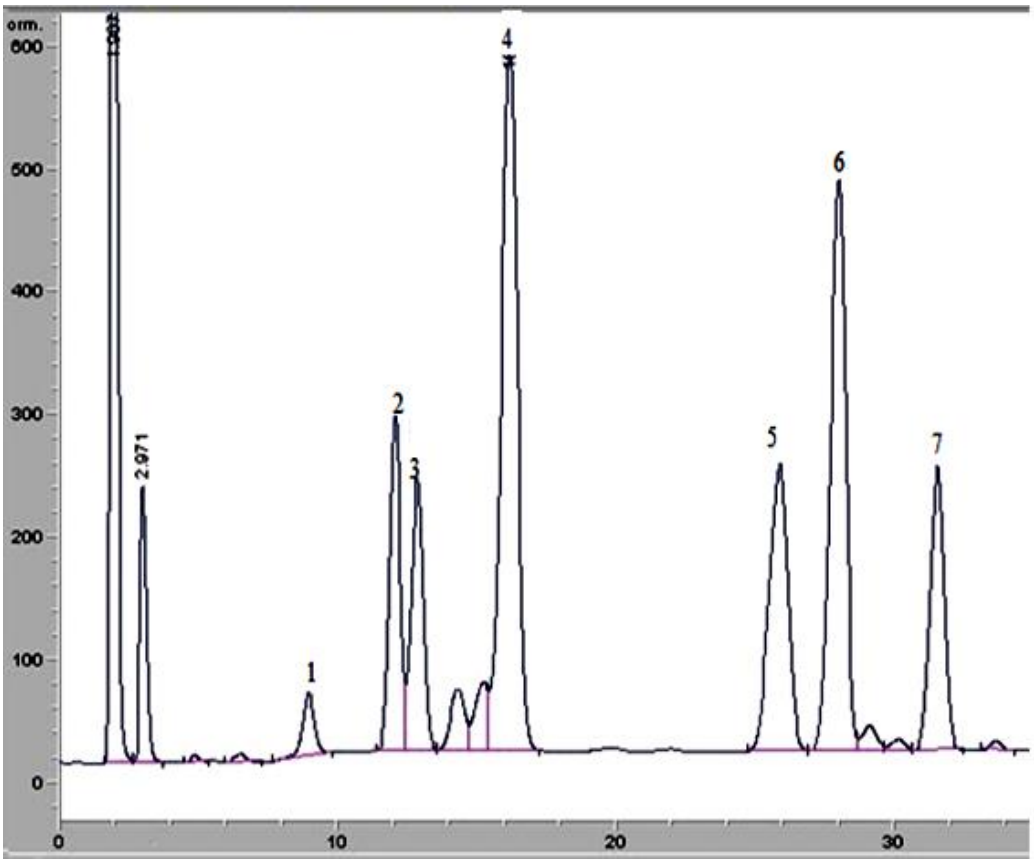
Leaven samples	n	Total phenolic content (µg GAE·mg sample^{-1})	β-carotene bleaching assay (%)	TEAC (IC_{50} µg·ml^{-1})	DPPH (IC_{50} µg·ml^{-1})
L1	2	528.34 ±34.64^{a}	76.25 ±1.44^{b}	10.75 ±1.24^{ab}	2.46 ±0.82^{a}
L2	2	372.34 ±33.31^{b}	84.59 ±2.81^{a}	7.38 ±2.91^{bc}	2.82 ±0.77^{a}
L3	2	401.14 ±21.07^{b}	84.44 ±1.83^{a}	6.29 ±3.13^{bc}	1.30 ±0.64^{b}
L4	2	404.14 ±25.97^{b}	83.85 ±1.65^{a}	12.81 ±2.32^{a}	0.94 ±0.41^{b}
L5	2	423.34 ±29.61^{b}	86.45 ±0.95^{a}	3.17 ±2.20^{c}	0.82 ±0.31^{b}
BHA	2	–	98.76	–	–
Trolox	2	–	–	11.10	28.20

All the trials were performed in triplicate (n = 3) and all the data were reported as means ± SD; data in the same column with different letters are significantly different (p < 0.01)

Rose leaven

The differences in total phenolics content and antioxidant activities among rose leavens were statistically significant ($P < 0.01$, tab. 5). L1 possessed the highest TPC, with a level of 528.34 µg GAE·mg sample^{-1}, followed by L5 of 423.34 µg GAE·mg extract^{-1}. L4 (404.14 µg GAE·mg extract^{-1}), L3 (401.14 GAE·mg extract^{-1}) and L2 (372.34 µg GAE·mg extract^{-1}) had relatively lower TPC. All extracts had lower antioxidant activities than had BHA (tab. 5). The antioxidant activity of leaven extracts followed the order: L1 (76.25 ±1.44%) < L4 (83.85 ±1.65%) < L3 (84.44 ±1.83%) < L2 (84.59 ±2.81) < L5 (86.45 ±0.95). Table 5 shows DPPH of rose syrup ethanolic extracts. In general, IC_{50} values of all tested samples through DPPH scavenging activity test were ranging from 0.82 to 2.82 µg ml^{-1} and the DPPH scavenging activity is arranged in the following descending order: L5 > L4 > L3 > L1 > L2.

Analysis of anthocyanins in rose leaven by means of HPLC were performed. Figure 1 showed anthocyanin profile of rose leaven using HPLC chromatogram at 520 nm. The typical HPLC chomatogram of anthocyanin extracts shows 9 peaks (fig. 1). Attending to the retention time in HPLC it was possible to identify 7 anthocyanic compounds (tab. 6).



1 – delphinidin chloride (µg·l^{-1}) RT: 8.922; 2 – cyanidin-3,5-di-O-glucoside (µg·l^{-1}) RT: 12.024; 3 – malvidin-3, 5-diglucoside (µg·l^{-1}) RT: 12.833; 4 – pelargonidin-3,5-di-O-glucoside chloride (µg·l^{-1}) RT: 16.149; 5 – pelargonidin--3-O-glucoside chloride (µg·l^{-1}) RT: 25.841; 6 – apigenin-7-glucoside (µg·l^{-1}) RT: 27.970; 7 – cyanidin-3-O-glucoside chloride (µg·l^{-1}) RT: 31.510

Fig. 1. HPLC chromatogram of anthocyanin extracts

Table 6. Total monomeric anthocyanin and individual anthocyanin content of rose leavens

Anthocyanin content	Rose leavens				
	L1	L2	L3	L4	L5
n	2	2	2	2	2
Total anthocyanin (mg·100 ml^{-1})	120.31 ±0,00^{a}	105.2 ±0.00^{b}	25.05 ±0.00^{c}	10.02 ±0.00^{d}	80.15 ±0.00^{d}
Malvidin-3,5-diglucoside (µg·l^{-1})	8.08 ±0,00^{d}	7.65 ±0.00^{e}	9.50 ±0.00^{c}	12.29 ±0.00^{b}	13.47 ±0.00^{a}
Cyanidin-3-O-glucoside chloride (µg·l^{-1})	13.34 ±0.00^{c}	12.17 ±0.00^{d}	6.05 ±0.00^{e}	16.26 ±0.00^{a}	14.80 ±0.00^{b}
Apigenin-7-glucoside (µg·l^{-1})	13.34 ±0.00^{c}	12.17 ±0.00^{d}	6.05 ±0.00^{e}	16.26 ±0.00^{a}	14.80 ±0.00^{b}
Cyanidin-3,5-di-O-glucoside (µg·l^{-1})	5.46 ±0.00^{d}	4.15 ±0.00^{e}	12.49 ±0.00^{b}	9.13 ±0.00^{c}	17.19 ±0.00^{a}
Pelargonidin-3,5-di-O-glucoside chloride (µg·l^{-1})	20.93 ±0.00^{c}	16.93 ±0.00^{d}	12.41 ±0.00^{e}	24.50 ±0.00^{b}	29.60 ±0.00^{a}
Delphinidin chloride (µg·l^{-1})	2.21 ±0.00^{e}	3.21 ±0.00^{d}	6.47 ±0.00^{a}	3.44 ±0.00^{c}	3.45 ±0.00^{b}
Pelargonidin-3-O-glucoside chloride (µg·l^{-1})	4.94 ±0.00^{d}	5.79 ±0.00^{b}	11.36 ±0.00^{a}	1.62 ±0.00^{e}	5.52 ±0.00^{c}

All the trials were performed in triplicate (n = 3) and all the data were reported as means ± SD; TAC expressed as mg of cyanidin-3-glucoside per 100 ml; data in the same column with different letters are significantly different (p < 0.01)

Table 7. Antimicrobial properties of rose leavens extracts

Food borne-microorganisms	L1	L2	L3	L4	L5	Positive control*
n	2	2	2	2	2	2
Acinetobacter lwoffii 2819	9.33 ±0.58^{b}	8.67 ±0.58^{b}	–	9.33 ±0.58^{b}	19.00 ±1.00^{a}	17 (AMC30)
Bacillus cereus 6230	7.17 ±0.76^{c}	–	12.33 ±0.58^{b}	7.17 ±0.29^{c}	15.00 ±1.00^{a}	12 (CC2)
Candida albicans ATCC 1223	–	–	–	–	–	15 (AMP20)
Candida albicans ATCC 90059	–	–	–	–	–	15 (AMP20)
Candida krusei ATCC 14243	–	–	–	–	–	15 (AMP20)
Escherichia coli GM 1402	–	–	–	–	–	18 (CC2)
Listeria ivanovii GM 8353	–	–	–	–	–	19 (CC2)
Proteus mirabilis GM 2644	12.67 ±0.58^{ab}	8.00 ±1.00^{d}	13.67 ±0.58^{a}	11 ±2.00^{bc}	9.33 ±0.58^{cd}	12 (OFX10)
Saccharomyces boulardii 6128	–	–	–	–	–	9 (AMP20)
Saccharomyces cerevisiae 6541	–	–	–	–	–	8 (AMP20)
Salmonella typmiruim RSSK 95091	–	–	–	–	–	9 (OFX10)
Staphylococcus aureus ATCC 29213	9.33 ±0.58^{c}	9.33 ±1.53^{c}	14.00 ±1.00^{b}	8.33 ±0.58^{c}	18.33 ±1.53^{a}	20 (SCF105)
Streptococcus mutans ATCC 35668	10.00 ±0.00^{b}	14.00 ±0.00^{a}	14.00 ±1.00^{a}	10.67 ±0.58^{b}	14.67 ±0.58^{a}	18 (AMP10)
Yersinia enterocolitica	9.00 ±0.00^{b}	12.00 ±1.00^{a}	12.33 ±0.58^{a}	9.67 ±0.58^{b}	11.67 ±0.58^{a}	26 (AZM15)

– no inhibition zone

* SCF105 (30 µg sulbactam + 75 µg cefoperazona/disc), CC2 (2 µg clindamycin/disc), OFX10 (10 µg ofloxacin/disc), AMC30 (20 µg amoxicillin + 10 µg clavulanic asit/disc), AZM15 (15 µg azithromycin/disc), AMP20 (20 µg Amphotericin B/disc), AMP10 (10 µg Amphotericin B/disc) used as positive standards antibiotic discs (oxoid)

Table 8. Total phenolic contents and antioxidant capacities of rose syrup

z	S1	S2	BHA	Trolox
Total phenolic content (μg GAE·mg sample^{-1})	64.94	1.36	–	–
β-carotene bleaching assay (%)	80.17	nd	98.76	–
TEAC (IC_{50}, μg·ml^{-1})	15.08	nd	–	11.10
DPPH (IC_{50}, μg·ml^{-1})	38.83	nd	–	28.20

nd – not determined

Table 9. Total phenolic contents and antioxidant capacities of rose jam

Parameters	n	Total phenolic content (μg GAE·mg sample^{-1})	β-carotene bleaching assay (%)	TEAC (IC_{50}, μg·ml^{-1})	DPPH (IC_{50}, μg·ml^{-1})
J1	2	65.54 ±3.99^{a}	20.35 ±1.87^{e}	18.88 ±0.84^{a}	36.97 ±6.51a
J2	2	70.14 ±8.11^{a}	82.37 ±1.87^{c}	15.16 ±0.59^{b}	43.99 ±5.70^{a}
J3	2	46.40 ±4.20^{b}	86.45 ±0.95^{a}	15.16 ±0.55^{b}	42.58 ±14.69a
J4	2	73.74 ±9.24^{a}	41.37 ±1.92^{d}	19.02 ±0.71^{a}	28.47 ±3.40^{a}
J5	2	44.74 ±5.03^{b}	80.18 ±0.56^{b}	16.41 ±0.60^{b}	42.78 ±17.25^{a}
BHA	2	–	98.76	–	–
Trolox	2	–		11.10	28.20

All the trials were performed in triplicate (n = 3) and all the data were reported as means ± SD; data in the same column with different letters are significantly different (p < 0.01)

The DAD data of leaven anthocyanins were presented in Table 6. The chromatograms obtained indicated the presence of 9 anthocyanin fractions. Seven of these fractions were identified as malvidin-3,5--diglucoside, cyanidin-3-O-glucoside chloride, apigenin-7-glucoside, cyanidin-3,5-di-O-glucoside, pelargonidin-3,5-di-O-glucoside chloride, delphinidin chloride and pelargonidin-3-O-glucoside chloride, but the first two fractions could not be identified.

The results of antimicrobial activity of ethanolic extracts are shown in Table 7. Based on these results, it is possible to conclude that methanolic extracts of leaven samples had different level antimicrobial activity.

Rose syrup

The total phenolic content of rose syrup was in the range of 1.36 to 64.94 μg GAE·mg sample^{-1}. Total antioxidant capacity of blackberry genotypes is shown in Table 2. Determination of antioxidant activities by β-carotene-linoleic acid, 2-diphenyl-1-picryhydrazyl (DPPH) free radical scavenging and TEAC assays (tab. 8). In the present study S1 showed antioxidant activity but S2 were not. In the β-carotene bleaching method, R1 showed high antioxidant activity but S2 were not antioxidant activity. In DPPH assay, IC_{50} values of S1 were 38.83 μg ml^{-1}. The mean TEAC value of S1 was 15.08 μg ml^{-1}.

Rose jam

Table 9 shows the total phenolic content of rose jam extracts. Among the studied jam samples, J4 had the highest total phenolic content (73.74 μg GAE·mg sample^{-1}), followed by J2 (70.14 μg GAE·mg sample^{-1}), J1 (65.54 μg GAE·mg sample^{-1}), J3 (46.40 μg GAE·mg sample^{-1}) and J5 (44.74 μg GAE·mg sample^{-1}). ANOVA showed significant differences

($p < 0.01$) in total phenolic content among the studied jam samples.

Antioxidant activity of rose petals extracts vas determined by β-carotene bleaching assay. Table 9 shows the antioxidant activity of the five jam extracts in the comparison with those of BHA. The antioxidant activity increased in the order J1 < J4 < J5 < J2 < J3 < BHA. BHA, used as the standard, had a higher antioxidant activity than jam extracts or control. A decrease in absorbance, for all the samples compared with the standard, indicates that all the studied jam samples possessed lower antioxidant capacity. The absorbance values for all the samples decreased with incubation time.

DPPH is a free radical compound and has been widely used to test the free radical-scavenging ability of various samples. It is a stable free radical with a characteristic absorption at 517 nm, was used to study the radical-scavenging effects of extracts. As antioxidants donate protons to this radical, the absorption decreases [Kubola and Siriamornpun 2008]. DPPH free radical-scavenging activity of the five jam extracts is presented in Table 9. IC_{50} values (concentration of sample required to scavenge 50% free radical or to prevent lipid peroxidation by 50%) were found to be the least in J4 (28.47 $\mu g \cdot ml^{-1}$), followed J1 (36.97 $\mu g \cdot ml^{-1}$), J3 (42.58 $\mu g \cdot ml^{-1}$), J5 (42.78 $\mu g \cdot ml^{-1}$) and J2 (43.99 $\mu g \cdot ml^{-1}$).

The antioxidant capacity of extracts was also determined by the TEAC method based on the inhibition by antioxidants of the absorbance of the radical cation ABTS. Significant differences in IC_{50} values were found between the 5 types of jam ($P < 0.05$).

CONCLUSIONS

Present study describe some important chemical properties such as total dry matter, total soluble solids, ash, pH, titratable acidity, reducing sugar, sucrose, total sugar, color (*L*, *a*, *b*), total phenolic content, antioxidant capacity, antimicrobial activities, anthocyanin and total phenolic content of some rosa traditional products for example rosa petals, syrups, jams and leavens. We found a wide variation among the products on most of the parameters searched. Rosa petals and leavens extracts showed significant antimicrobial activity indicating the importance of the use of those important traditional products.

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